

Dental Pocket and Type 2 Diabetes among Elderly People Aged 88 in Japan

- Report on Improvements to Analytical Methods

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Abstract

Background: This study aimed to clarify the relationship between periodontal pocket depth and type 2 diabetes in individuals aged 88. We re-examined the relationship between periodontal pockets and type 2 diabetes in 508 older adults aged 88 years, excluding those individuals without residual teeth or teeth available for periodontal pocket measurement.

Methods: The subjects of this study were individuals who underwent dental check-ups in Matsudo city for individuals aged 88 years. We performed binomial logistic regression analyses to examine the association of presence of periodontal pockets and type 2 diabetes.

Results: Logistic regression analyses with covariates showed a significant association between deep periodontal pockets and type 2 diabetes in the continuous teeth model (OR: 2.26, 95% CI: 1.23–4.16) and in the teeth categorical model (OR: 2.04, 95% CI: 1.22–3.44). The results were almost identical to the original findings.

Conclusion: A significant association was identified between periodontal pockets and an increased prevalence of type 2 diabetes among 508 Japanese individuals aged 88 years, after excluding those without residual teeth or teeth eligible for periodontal pocket measurement. These findings closely align with the original results and reinforce the importance of promoting dental check-ups, highlighting the role of oral hygiene in preventive healthcare even for those aged 88.

Keywords: Diabetes, Periodontal pockets, Dental check-up, Geriatric preventive health

1. Introduction

Diabetes is a global pandemic and one of the greatest public health challenges of the 21st century (International Diabetes Federation, 2021). Approximately 537 million people worldwide currently suffer from diabetes, with projections suggesting an increase to 643 million by 2030. Periodontitis, along with diabetes, represents a significant global health burden. It is estimated that periodontal disease affects up to 50% of the global population (Trindade et al., 2023), and its prevalence is expected to increase due to the aging population and prolonged exposure to risk factors associated with improved tooth retention among older adults (Nazir et al., 2020). In the elderly, dental caries and periodontal disease are reported to account for approximately 90% of tooth loss cases, thereby negatively impacting their quality of life (QOL) (MHLW, 2016).

Periodontitis is an infection-induced disease that leads to inflammation and destruction of the tissues supporting the teeth. Over 500 bacterial species contribute to plaque formation, with *Porphyromonas gingivalis*, *Tannerella forsythia*, *Prevotella intermedia*, and *Aggregatibacter actinomycetemcomitans* identified as primary culprits of periodontitis (Ezzo & Cutler, 2003).

Periodontal disease reduces masticatory ability, causing patients to avoid fiber-rich vegetables and instead

consume softer, sweeter foods, leading to increased carbohydrate and sugar intake (Morita et al., 2011). This dietary change, which results from reduced masticatory ability, has been linked to an increased risk of type 2 diabetes, particularly in individuals with periodontal pockets measuring 4 mm or more.

From a non-communicable disease (NCD) prevention perspective, including diabetes, maintaining functional teeth and oral health is crucial for older adults, as it preserves the joy of eating and improves QOL (Japan Dental Association, 2007). In recognition of this, the importance of dental check-ups has been reaffirmed in national policies. Japan's 2023 national policy framework ("Honebuto Policy 2023") emphasizes the promotion of lifelong dental examinations. The Ministry of Health, Labour and Welfare has announced plans to integrate mandatory dental check-ups into health examinations for older adults, with the Japan Dental Association supporting these initiatives (Japan Dental Association, 2023). The accumulation of evidence regarding lifelong dental check-ups is essential, especially for the oldest-old population, as data remains limited.

Several epidemiological studies in Japan have reported an association between periodontal pockets measured during dental check-ups and type 2 diabetes among workers and community residents. Miyawaki et al. (2016) found that tooth mobility was an independent predictor of type 2 diabetes onset among male workers aged 36–55 years. Similarly, Saito et al. (2004) described a relationship in which elderly individuals aged 50–79 years with periodontal disease were more likely to develop impaired glucose tolerance. Although evidence on incidence rates is accumulating, reports on the oldest-old population remain limited. We previously reported a cross-sectional association between periodontal pocket depth and type 2 diabetes in a preventive health context, using data from 590 Japanese individuals aged 88 years, including individuals without residual teeth or teeth available for periodontal pocket measurement (Komoto et al., 2024). In this report, we conducted a refined analysis, excluding individuals without residual teeth or teeth available for periodontal pocket measurement.

2. Methods

The current study design is a population-based cross-sectional study with participants from the administrative service program. Matsudo City in Chiba Prefecture started dental check-ups in dental clinics and through home visit dentistry for insured individuals aged 88 years to celebrate their age in accordance with Japanese culture. The subjects of this study were 664 individuals who underwent a dental check-up in Matsudo City among 2,220 individuals aged 88 years between 2019 and 2021.

Dental health check-ups were conducted as part of public health services; therefore, consent was not obtained from participants. We obtained permission from Matsudo City to use the data anonymously to promote health promotion among insured older individuals, and this study was approved by the Ethics Committee of Wayo Women's University (authorization No. 2261). This study was conducted in accordance with the World Medical Association Declaration of Helsinki, the Ethical Guidelines for Epidemiological Research of the Ministry of Education, Culture, Sports, Science and Technology, and the guidelines of the Ministry of Health, Labour and Welfare, Japan.

Dental examinations were conducted by trained dentists who recorded periodontal pocket depth at six points around each tooth (mesio-buccal, mid-buccal, disto-buccal, mesio-lingual, mid-lingual, disto-lingual). Measurements were taken in millimeters, with the most conservative values assigned for uncertain cases. Periodontal pockets were classified as either deep (≥ 4 mm) or shallow (< 4 mm, including healthy and mild pockets).

Data on participants' oral health included the number of residual teeth and overall oral health status (good or poor) assessed using the Oral Health Assessment Tool (OHAT-J) (Matsuo & Nakagawa, 2016). The number of remaining teeth was categorized into the following groups: 1–5, 6–10, 11–15, 16–20, 21–25, and 26 or more. Participants' basic demographics, health conditions, and lifestyle factors—such as gender, living arrangement (home or facility including nursing homes, assisted living facilities, or care homes), smoking history, obesity, history of stroke/myocardial infarction, rheumatoid arthritis, and type 2 diabetes—were also collected.

Participants with missing data and those without residual teeth or teeth that could be evaluated for periodontal pockets were excluded, leaving 508 participants for analysis. Bivariable descriptive analyses were performed using χ^2 tests or Welch's t-tests. Logistic regression models were used to estimate odds ratios (ORs) and 95% confidence intervals (CIs), adjusting for covariates. Statistical significance was set at $p < 0.05$. Analyses were conducted using Stata 16.1.

3. Results

The analysis included 508 participants, consisting of 217 men (42.7%) and 291 women (57.3%), most of whom resided in facilities (95.7%). Of the participants, 27.0% were current or former smokers, 1.8% were obese, 18.3% had a history of stroke/myocardial infarction, and 2.4% had rheumatoid arthritis. Type 2 diabetes was observed in

11.0% of participants ($n = 56$). Good oral health, as assessed by the OHAT-J, was observed in 72.0% of participants, and 63.8% had undergone dental check-ups. Deep periodontal pockets were found in 40.7% of participants. Bivariate analyses (Table 1) revealed significant associations between diabetes and stroke or myocardial infarction ($p = 0.035$) and deep periodontal pockets ($p = 0.003$).

Logistic regression analyses (Table 2) with covariates showed a significant association between deep periodontal pockets and type 2 diabetes in the continuous teeth model (OR: 2.26, 95% CI: 1.23–4.16) and in the categorical teeth model (OR: 2.04, 95% CI: 1.22–3.44). The results were nearly identical to the original findings (OR: 2.02, 95% CI: 1.13–3.59), with a marginally higher OR in the present analysis. No other variables showed significant associations with type 2 diabetes after adjusting for covariates.

Table 1. Subjects Characteristics and Distribution of Cases of Type2 Diabetes ($N=508$)

Items		No Diabetes		Diabetes		P-value
Sex	Male	191	88.0%	26	12.0%	0.552 [†]
	Female	261	89.7%	30	10.3%	
Living	In-Facility	435	89.5%	51	10.5%	0.073 [†]
	In-Home	17	77.3%	5	22.7%	
Smoking	Never/Past	330	88.9%	41	11.1%	0.974 [†]
	Current	122	89.1%	15	10.9%	
Obesity	No	445	89.2%	54	10.8%	0.279 [†]
	Yes	7	77.8%	2	22.2%	
Infarction	No	375	90.4%	40	9.6%	0.035 [†]
	Yes	77	82.8%	16	17.2%	
Rheumatism	No	441	88.9%	55	11.1%	0.763 [†]
	Yes	11	91.7%	1	8.3%	
Oral health	Bad	121	85.2%	21	14.8%	0.091 [†]
	Good	331	90.4%	35	9.6%	
Dental check-up	No	159	86.4%	25	13.6%	0.164 [†]
	Yes	293	90.4%	31	9.6%	
Dental pocket	No	278	92.4%	23	7.6%	0.003 [†]
	Yes	174	84.1%	33	15.9%	
Remaining teeth	Cont.	19.3	SD:7.5	18.2	SD: 7.5	0.323 [‡]
(Reclassification)	1 – 5	22	88.0%	3	12.0%	0.527 [†]
	6 – 10	46	82.1%	10	17.9%	
	11 – 15	76	91.6%	7	8.4%	
	16 – 20	69	88.5%	9	11.5%	
	21 – 25	130	88.4%	17	11.6%	
	26 –	109	91.6%	10	8.4%	

†: Chi-square test, ‡ Welch's t-test.

Table 2. Association of Type2 Diabetes and dental pocket among older adults aged 88 in Japan

Items	Continuous model		Categorical model	
	OR	95% CI	OR	95% CI
Sex, Female (ref: Male)	0.95	0.47–1.92	0.98	0.48–1.99
Living, In-Facility (ref: In-Home)	0.40	0.13–1.18	0.41	0.13–1.23
Smoking, Current (ref: Never/Past)	0.90	0.42–1.95	0.90	0.41–1.96
Obesity, Yes (ref: No)	2.76	0.52–14.63	3.09	0.58–16.55
Infarction, Yes (ref: No)	1.92	0.99–3.73	1.86	0.95–3.62
Rheumatism, Yes (ref: No)	0.82	0.10–6.82	0.71	0.09–5.94
Oral health, Good (ref: Bad)	0.89	0.47–1.67	0.91	0.48–1.72
Dental check-up, Yes (ref: No)	0.76	0.42–1.38	0.73	0.41–1.33
Dental pocket, Yes (ref: No)	2.26	1.23–4.16	2.26	1.22–4.16
Remaining teeth, Number	0.98	0.94–1.02	—	—
Remaining teeth	1-5	—	—	1.00
	6-10	—	1.89	0.44–8.01
	11-15	—	0.81	0.18–3.55
	16-20	—	1.12	0.26–4.78
	21-25	—	1.07	0.27–4.21
	26-	—	0.80	0.19–3.32

Logistic regression model, $N=508$, OR: Odds Ratio, CI: Confidence Interval.

4. Discussion

Among 508 Japanese individuals aged 88 years, excluding those without residual teeth or teeth available for periodontal pocket measurement, we observed a significant association between the presence of periodontal pockets and a higher prevalence of type 2 diabetes. The results were almost identical to the original findings, which supports the policy direction of promoting dental check-ups, as maintaining oral hygiene is associated with preventive health even among people aged 88 years.

If a periodontal pocket of 4 mm or more was present, the number of patients with diabetes was significantly higher than those with pockets less than 4 mm, as demonstrated in both the continuous and categorical models. No significant differences in the number of remaining teeth were observed in either the continuous or categorical models. The odds ratio for having 6-10 remaining teeth was relatively high at 1.89. While it was expected that a greater number of remaining teeth would proportionally increase the extent of inflammation due to periodontal pockets, this dose-response relationship was not observed. Considering that the odds ratios for other remaining teeth categories were close to 1.0 and that no significant difference was detected, these findings suggested that even a small degree of inflammation may have a significant impact rather than a simple dose-response relationship.

Declines in oral function, including the deterioration of periodontal pockets, affect overall health, highlighting the growing importance of dental check-ups. Since oral health deterioration progresses gradually without noticeable pain, it is often regarded as a natural consequence of aging, making it difficult to identify as a health concern (Sato et al., 2019). Early detection and treatment, which are essential for the effectiveness of health check-ups, are thus considered particularly valuable (Furuta et al., 2023).

According to the National Survey “2019 Comprehensive survey of living conditions”, oral diseases rank as the third most common reason for medical visits among men and the fourth among women, underlining their high prevalence and the importance of dental check-ups. Expenditure on dental healthcare amount to approximately 3 trillion yen, accounting for about 7% of Japan’s total healthcare costs and ranking third overall (MHLW, 2021). From the perspective of treating dental healthcare as an investment in overall health, the return on this investment is considered significant.

There are challenges to implementing universal dental check-ups. Designing universal dental check-ups would not be straightforward, as the level of dental healthcare infrastructure and workforce varies across municipalities. The difficulties are expected to be greater in rural areas than in urban regions (Toyokawa & Kobayashi, 2010).

Additionally, increasing participation rates remains a challenge. To improve screening uptake, considerations include designing incentives, enhancing access for low-income groups, and exploring free screening options are necessary. Furthermore, evidence on the cost-effectiveness of dental check-up programs is needed. Comprehensive evaluations, including these indicators, remain an area of focus for future research.

This report shares several limitations with the original study. First, as this was a cross-sectional study, it has inherent limitations in assessing causality. Second, since the participants were not randomly selected from a single municipality, the findings may not be generalizable to the broader population. Third, type 2 diabetes may also exhibit reverse causation, potentially contributing to the deterioration of periodontal pockets. For instance, individuals with type 2 diabetes often experience reduced salivary secretion and elevated salivary glucose levels, which promotes plaque adhesion and the progression of periodontal disease.

5. Conclusion

In a study of 508 Japanese individuals aged 88, after excluding those without residual teeth or teeth eligible for periodontal pocket measurement, we identified a significant association between periodontal pockets and an increased prevalence of type 2 diabetes. These findings are consistent with the original results and reinforce the importance of promoting dental check-ups, emphasizing the role of oral hygiene in preventive healthcare, even for those aged 88.

Authors' Contributions

MK and ST contributed to the concept and design of the study and conducted the statistical analyses. MK and ST had full access to all study data and were responsible for data integrity, and MK and ST were responsible for the accuracy of the data analyses. KT, TF, and YY were responsible for the interpretation of the results and drafting the manuscript, critically reviewing, agreeing to publish it and controlling the decision to publish. The authors read and approved the final manuscript.

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Availability of Data and Materials

The data used to derive our conclusions are unsuitable for public deposition due to ethical restrictions imposed by the municipality.

Ethics Approval and Consent to Participate

Ethics approval for this study was obtained from the Ethics Committee of Wayo Women's University (authorization no. 2261). Under the research agreement between the research municipality and our group, we obtained the data in an anonymous format.

Patient Consent Statement

Not Applicable

Clinical Trial Registration

Not Applicable.

Competing Interests Statement

The authors declare that they have no competing interests.

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